Weather Note

TORNADOES OF JANUARY 21, 1959—A FEATURE OF A WEATHER SINGULARITY?

ROBERT R. DICKSON

U.S. Weather Bureau, Nashville, Tenn.

[Manuscript received February 2, 1959]

ABSTRACT

The tornadoes of January 21, 1959, in Tennessee and neighboring States are considered in relation to the New England January thaw singularity described by Wahl [1]. This singularity, in the form of a warm spell, is shown to occur on the average on January 20–22 at Nashville. It is shown that at the time of the singularity there coexist on the average in the Tennessee area certain conditions favorable for the formation of severe storms. These include a tongue of warm, moist air at the surface, a wind shift from southerlies during the warm period to cool northwesterlies immediately afterward, a 500-mb. trough to the west with southwesterly winds and contour inflection point over the Tennessee area, and the presence of a jet stream aloft. Review of past records reveals that tornadoes in the Arkansas, Alabama, Mississippi, Tennessee, and Kentucky area have occurred more often during the time of the singularity, January 20–22, than at any other time of the month.

1. INTRODUCTION

On January 18, 1959, surface winds from the Gulf Coast northward to the Great Lakes shifted to southerly quadrants, heralding the end of the existing cold spell. From Kentucky southward this warming continued through the morning of January 21, culminating in temperatures of 70° F. or higher over most of the Southeast. The surface weather system responsible for the final northward surge of warm, moist air was an intense open wave on the polar front which moved rapidly from central Texas to near Detroit by 0000 GMT, January 22. As the associated cold front swept across the Southeast displacing maritime tropical air, a series of severe thunderstorms and tornadoes broke out. Preliminary reports placed tornado activity in Mississippi, Alabama, Tennessee, and Kentucky. As the tornado-spawning Low moved northeastward, 60° F. temperatures reached northward to Boston prior to the cold front passage near noon on January 22.

2. THE NEW ENGLAND JANUARY THAW SINGULARITY

The advent of 60° F. temperatures in the Boston area on January 22, 1959, occurred at precisely the period (January 20–23) of the New England January thaw singularity described by Wahl [1]. Compared with the normal January daily maximum temperature at Boston of 36.5° F., this January 22 warming constituted an exceedingly well-developed example of the singularity.

Wahl discussed the validity of the January thaw singularity for the eastern portion of the United States, using data for the Boston, New York, Washington, D.C., and Columbia, Mo., areas. Evidence of this singularity in Tennessee may be found in figure 1a. Mean daily temperature at Nashville, averaged over the period 1871–1950 [2], shows an increase to 41.9° F. on January 21—nearly 3° warmer than the average temperature 2 days before or 3 days after that date. Thus the Tennessee counterpart of the New England January thaw singularity is established as occurring on January 20–22.

3. SYNOPTIC IMPLICATIONS

Wahl [1] illustrates the remarkable extent to which the singularity shows up in 40-year average sea level pressure patterns. His figure 4b shows the existence of warming southerly winds on January 20 from the Gulf of Mexico to New England, accompanying the warm-spell singularity on January 20–22 at Nashville and January 20–23 in New England. By January 27, as indicated in his figure 4c, the warm air over the eastern half of the country has been swept away by a cold High from the northwest. Figures 1b

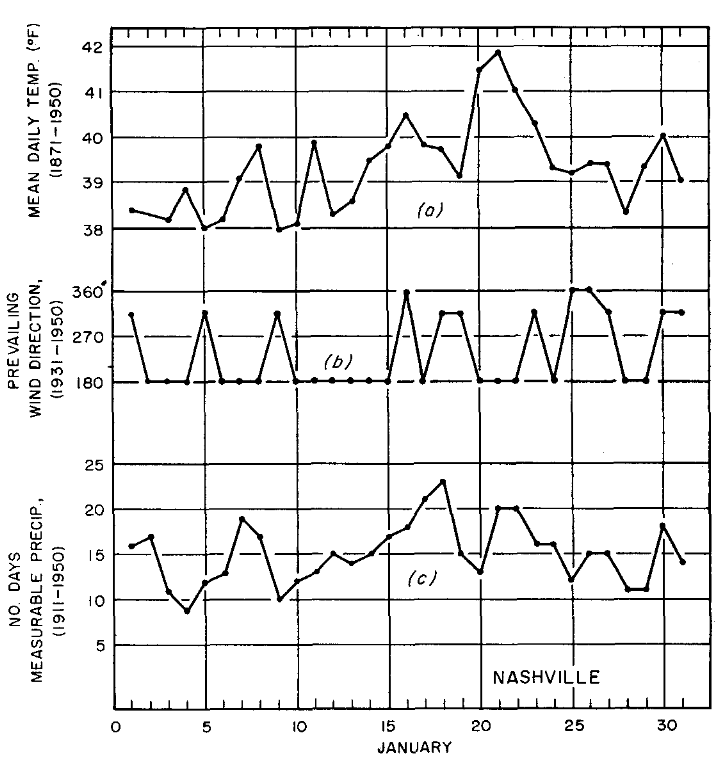

FIGURE 1.—Data for Nashville, Tenn. (a) Daily average temperature, 1871–1950; (b) Prevailing wind direction, 1931–1950; (c) Frequency of days with measurable precipitation, 1911–1950.

and 1c serve to document this sequence of events further. Prevailing wind at Nashville [3] is from the south on January 20–22 giving way to northwesterly winds on January 23, thus suggesting a cold front passage. It is of interest to note that on January 21 prevailing winds at Nashville are from the quadrant SW–SE 70 percent of the time. Figure 1c shows a secondary maximum in the frequency of days with measurable precipitation at Nashville [3] on January 21 and 22 accompanying the wind shift described above.

To further assay the potential of the synoptic situation associated with the January 20–22 warm-spell singularity, the concurrent upper-level circulation was investigated. Figures 2 and 3 are 500-mb. mean charts and their departures from normal for January 20 and January 27 respectively for 1948–1957 (1955 missing). The 500-mb. trough on January 20 stretches from western Texas northward to the Great Lakes, a position near the January normal. However, the anomaly lines show that the southern portion of the trough is deeper than normal and winds over the eastern part of the country are more southerly than the January normal. Attention is also directed to the location of the 18,400-ft. contour on January 20 in the Arkansas, Kentucky, Tennessee area. As pointed out by Fletcher [4] the axis of maximum wind at 500 mb. is most frequently associated with the 18,400-ft. contour and is within the contour range 18,200–18,800 ft. 91.8 percent of the time. Since experience verifies a reasonably close identity between the location of the axis of maximum wind at 500 mb. and the jet stream core over the eastern United States, the jet stream on January 20 (fig. 2) can be considered to cross the Arkansas-Kentucky-Tennessee area near the 18,400-foot contour.

Figure 3 illustrates the eastward progression, shear, and decrease in intensity of the mean trough in central United States by January 27. Height change from the January 20 average map of figure 2 to the January 27 average map of figure 3 is shown in figure 4. The difference between these average daily 500-mb. charts one week apart is striking.

As shown by the long-term average circulation at both sea level and 500 mb., some of the necessary conditions for the generation of severe storms in the general area exist at the time of the January 20–22 warm-spell singularity in Tennessee. A surface tongue of warm (and by inference moist) air, introduced by persistent south winds, stretches from the Gulf through Tennessee to New England. This tongue of warm, moist air is subsequently displaced by cold air which brings a notable temperature drop and shifts surface winds from the south to the northwest in the Tennessee area. Aloft, a 500-mb. trough, deeper than normal in southern portions, lies immediately to the west, with southwesterly flow and contour inflection point over the Tennessee area. Furthermore, the axis of the jet stream, as deduced from 500-mb. contours, traverses the area.

4. TORNADO DISTRIBUTION IN JANUARY

A search of past records from 1931 through 1959 for the Alabama, Mississippi, Arkansas, Tennessee, Kentucky area [5] reveals a total of 28 tornado days during the month of January. Of these, six (21 percent) occurred from January 20–22 in association with the singularity under consideration. A similar concentration of tornado occurrence is found in only one other January period, January 29–31, when six tornado days have been observed. The number of tornadoes on any January day for the 1931–1958 period reaches a maximum of 12 on January 22 and does not exceed 5 on any other January day. Furthermore, preliminary, unverified reports indicate that 11 tornadoes occurred on January 21, 1959, to give a preponderance of January tornadoes during the January 20–22 warm-spell singularity.

5. CONCLUSIONS

Long-term average temperature data for Nashville give evidence in the Tennessee area of a warm-spell singularity on January 20–22—possibly the Tennessee counterpart of the New England January thaw singularity described by Wahl [1]. Examination of average circulation features at sea level and the 500-mb. level reveals the existence of certain conditions favorable for the development of severe storms in the Tennessee area at the time of the January

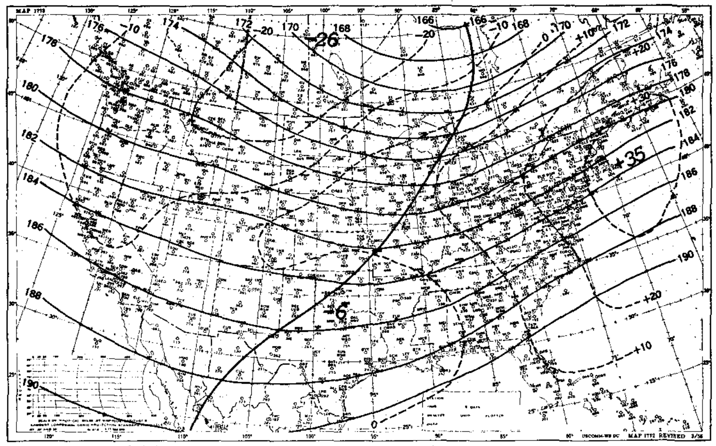

FIGURE 2.—500-mb. mean map for January 20, 1948–1957 (less 1955). Height contours (100's of feet) are solid lines, departures from normal (10's of feet) are dashed lines.

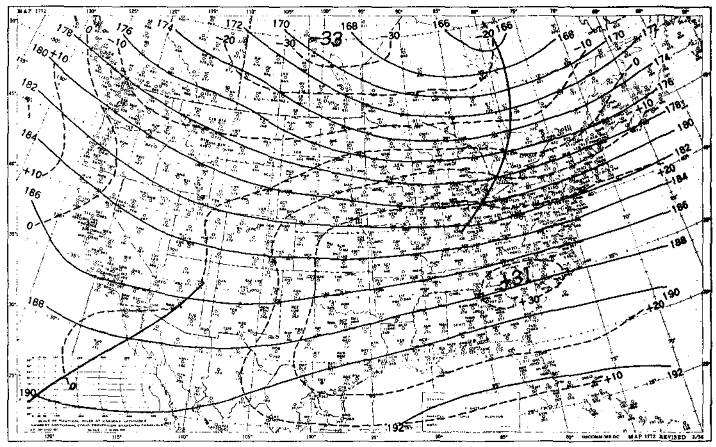

FIGURE 3.—500-mb. mean map for January 27, 1948–1957 (less 1955). Height contours (100's of feet) are solid lines, departures from normal (10's of feet) are dashed lines.

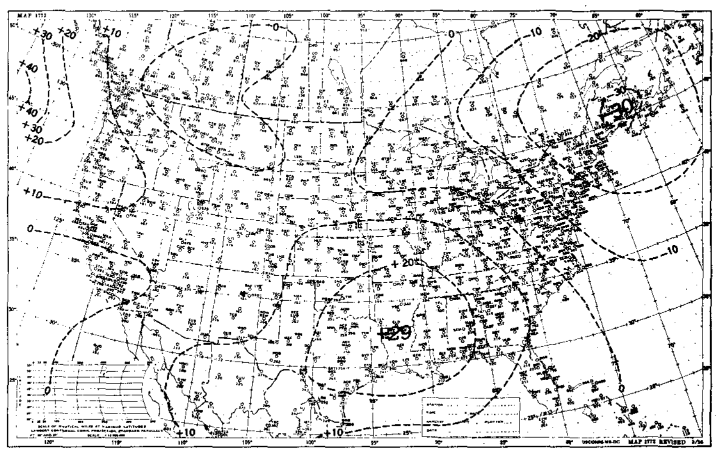

FIGURE 4.—500-mb. height change (10's of feet) from January 20 mean map (fig. 2) to that of January 27 (fig. 3).

20–22 warm-spell singularity. These include the presence of a warm, moist tongue of air in the lower atmosphere, passage of a cold front as suggested by a surface wind shift from persistent southerly winds prevalent during the warm spell to cooling northwesterly winds, a 500-mb. trough to the west with southwesterly winds and contour inflection point over the Tennessee area, and finally the presence of a jet stream aloft. It is suggested that in years when the singularity is especially well developed, as in January 1959, the singularity and its attendant circulation patterns at sea level and aloft provide the ingredients for the generation of severe storms in Tennessee and vicinity.

The results of this study are of value primarily as another bit of evidence dealing with the validity of a January 20–22 singularity in weather elements. Although the effect shows up more or less consistently in the long-term averages, it is not reliable enough to depend on every year. Because other sources of large variability are present, the singularity has limited value as a forecasting tool. It serves primarily to focus attention on the potential of the period.

This study was limited to an examination of the January 20–22 singularity in data for the Tennessee area in relation to the regional circulation singularity described by Wahl [1]. How the results fit into the worldwide pattern of January singularities suggested by several recent studies is a tempting question for further speculation. It is interesting to note, for example, that Brier's [6] data on hemispheric fluctuations in the meridional exchange of air at 50° N. latitude, Bowen's [7] rainfall data for a large number of stations in the Northern and Southern Hemispheres, Bigg's [8] high-level cloud data at Australian stations, and Kline and Brier's [9] freezing nuclei counts at Washington, D.C., also were peaked around January 20–24.

REFERENCES

1. E. W. Wahl, "The January Thaw in New England—An Example of a Weather Singularity," *Bulletin of the American Meteorological Society*, vol. 33, No. 9, Nov. 1952, pp. 380–386.
2. Climatological Record Book for Nashville, Tenn., 1931–1950 (unpublished).
3. Unpublished tabulations on file at Weather Bureau Airport Station, Nashville, Tenn., prepared by N. R. Davis.
4. R. D. Fletcher, "The Association of Wind Speed with Height of Upper-Air Constant Pressure Surfaces," *Bulletin of the American Meteorological Society*, vol. 34, No. 4, Apr. 1953, pp. 155–159.
5. U.S. Weather Bureau, Washington, D.C., (a) *Climatological Data, National Summary*, 1950–1958 annual issues; (b) U.S. *Meteorological Yearbook*, issues for 1935–1949; (c) Report of the Chief of the Weather Bureau, 1931–32 to 1933–34.
6. G. W. Brier, "A Note on Singularities," *Bulletin of the American Meteorological Society*, vol. 35, No. 8, Oct. 1954, p. 378.
7. E. G. Bowen, "The Relation Between Rainfall and Meteor Showers," *Journal of Meteorology*, vol. 13, No. 2, Apr. 1956, pp. 142–151.
8. E. K. Bigg, "January Anomalies in Cirriform Cloud Coverage over Australia," *Journal of Meteorology*, vol. 14, No. 6, Dec. 1957, pp. 524–526.
9. D. B. Kline and G. W. Brier, "A Note on Freezing Nuclei Anomalies," *Monthly Weather Review*, vol. 86, No. 9, Sept. 1958, pp. 329–333.

NOTICE

Effective with this issue (January 1959) the 17 climatological charts ordinarily inserted at the end of each issue will be discontinued in the *Monthly Weather Review*. They will continue to be printed (in black and white) in the *Climatological Data, National Summary* which is also issued monthly.

Paid subscribers to the *Review*, who do not already receive the *Climatological Data, National Summary*, will be added to the *CDNS* mailing list for six months or until their present *Review* subscriptions expire, whichever is earlier. Cooperators who need the charts will be placed on the mailing list for the *Climatological Data, National Summary* upon request to Chief, U.S. Weather Bureau, Washington 25, D.C.

U. S. GOVERNMENT PRINTING OFFICE: 1959